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Towards a better understanding of wind-induced pressure-pumping - a chamber system to simulate dynamic fields of pressure fluctuations

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Gas transport in soils is generally dominated by molecular diffusion. Yet, several studies showed that other factors such as wind-induced pressure-pumping can substantially enhance soil gas transport for a certain time. The underlying processes behind wind-induced enhancement of soil gas transport are very complex and there is an ongoing discussion about it. It has been observed that turbulence associated with high above-canopy wind speed generates pressure fluctuations that propagate into the air filled soil pore network. The resulting 2D pressure field travels in wind direction over the ground and generates lateral pressure gradients in the soil (Laemmel et al., 2019). We hypothesize that the 2D oscillation of the pressure gradient in the soil significantly contributes to the pressure-pumping effect (*PPE*) compared to a purely 1D pressure oscillation.

Previous studies relied on a monitoring of gas transport rates in the soil, which needed to cover calm and windy periods. In order to quantify *PPE* at different soils and to investigate the influence of 2D versus 1D pressure fields we develop a large mobile chamber system (approx. 2 x 4 m) with separated compartments to simulate dynamic 2D fields of pressure fluctuations in the field. By alternately pumping air in and out of the chamber sinusoidal pressure fluctuations can be generated. Pressure fluctuations in the different compartments can be set with a time-lag to create a lateral gradient between the compartments and thereby simulate 2D pressure fields.

Combined with automated chamber measurements and soil gas profile measurements inside the chamber system the influence of pressure-pumping on soil gas efflux can be investigated while the influence of other environmental drivers can be excluded. In the natural environment windy periods often coincide with other parameters like precipitation or temperature which also influence gas transport in soil. Excluding these factors could allow a clearer quantification of *PPE*. With this chamber system also the influence of wind speed directly above the ground in comparison to the influence of pure pressure-pumping could be investigated. Artificially simulating pressure-pumping has the advantage over the monitoring of natural pressure-pumping events that different scenarios can be run under controlled conditions and with replications. Additionally, artificially simulating pressure-pumping saves a lot of time since there is no need to wait for the right wind conditions. We believe that this set up will help to gain a better understanding of wind-induced pressure-pumping on a process level.

Literature:

Laemmel, T., Mohr, M., Schack-Kirchner, H., Schindler, D., & Maier, M. (2019). 1D Air Pressure Fluctuations Cannot Fully Explain the Natural Pressure-Pumping Effect on Soil Gas Transport. Soil Science Society of America Journal, 83(4), 1044-1053.